DEVICE FOR CONVERTING ELECTRIC ENERGY INTO A MECHANICAL ONE AND/OR FOR DOING THE OPPOSITE AND METHOD FOR PRODUCING SUCH A DEVICE

The invention relates to a device for converting electric energy into mechanical energy and/or the opposite according to the disclosure part of Claim 1 as well as a method for producing such a device.

In known devices the ends of the windings which are the coil windings of the rotor and/or the stator stand at some acceptable distance over the coil windings and are guided in circumferential direction in relation to a common point. There, the relevant ends of the windings are pressed together with one another, thus forming groups of connections, and then are provided with an electrical connection element. This requires costly and essentially manually executable laying out of the winding ends and also increases the dimensions of the structure, since the winding ends must be guided over the coil windings. Also, the connection between the connection device and the pressed-on winding ends, especially under environmental conditions which generate reactions thereto, represents a possible source of breakdown during operation of the device which has been produced, for example because of corrosion of the contacts.

DE 195 44 830 A1 shows a stator for electric motors in which the winding ends of a connection group are connected with one another by electrically conducting connection distributors running in circumferential direction. The connection distributors have connection soldering lugs to which the winding ends or the motor connection conductors are welded or soldered.

US 5,806,169 shows a method for the production of an electric motor in which the stator is spray-injected and injection molded following the welding of the stator windings onto corresponding connection soldering lugs by means of an injection molding technique using a synthetic resin material.

The object of the invention is therefore to disclose a device to overcome the problem by using such a device, and an associated method of production of the device, which method and device overcome the drawbacks of the state of the art, particularly by incorporating small structural dimensions, high contact reliability and a long life, even under aggressive environmental conditions, and which can be manufactured simply.

The problem is solved by the device disclosed in Claim 1, as well as by the method which is also disclosed. Particular embodiments of the invention are disclosed in the dependent claims.

The device according to Claim 1 can be a motor or a generator, particulary a combined alternating- or direct current-powered motor/generator device. Thus, coil windings could be arranged both on the rotor and on the stator, corresponding to the number of poles found on the device. The switch connection of the individual winding ends occurs according to the invention by means of a connection device with formation of connection groups or contact groups. With a three-phase alternating current device, for example, three (delta-wound circuit), four (star-wound circuit with spread-out star) or six connection or contact groups are formed. With six groups of connections, a switchover from star operation to three-phase operation and vice versa can also occur outside the device by suitable switching of the groups of connections. The rotor can be running on the interior or on the exterior in relation to the stator. A rotor having identical mass but running on the exterior has greater moments of inertia and torque. The connection distributor

is guided toward the outside of the rotor or stator and there forms one piece with a connection device. This occurs preferably by suitable bending or shaping of a copper band or strip serving as connection distributor to a mechanical sleeve or bearing or plug element.

According to the particular embodiment disclosed in Claim 3, the winding ends could advantageously be quite short. This leads not only to savings of material but also to small structural dimensions for the entire device. In the case of a rotor winding the rotor then has a slight imbalance which is a condition of this the type of construction.

According to the particular embodiment as in Claim 4, the connection distributors which may be annular in construction have cutting/clamping devices of one integral piece on the corresponding points at which the winding ends can be embedded, whereby the winding insulation is cut through at those points upon the pressing in of the winding ends. The cutting/clamping device in turn is preferably arranged precisely in relation to the associated winding ends. The cutting/clamping device can be set up ready for use by corresponding provision of a copper strip or copper ring used as connection distributor.

The particular embodiment of Claim 5 provides essentially circular connection distributors, aligned coaxially with the stator/rotor axis. The special type of embodiment of Claim 6 as connection distributor preferably provides a copper band or strip, whereby the band or strip width is aligned parallel to the rotor or stator axis. According to Claim 7 two bands or strips are present for each connection group, which bands or strips are guided in one piece toward the exterior of the device and there form a mechanical sleeve or bearing area for a connection device by means of suitable semi-circular bending, whereby in the mechanical sleeve or bearing area the band or strip width is aligned parallel to the longitudinal axis of a plug element to be inserted

into the mechanical sleeve or bearing. According to Claim 8 the two bands in the mechanical sleeve or bearing area are secured flexibly by a flexible elastic element.

The special type of embodiment as in Claim 9 has an axial or radial arrangement of the connection distributors aligned one after the other, whereupon the radial or axial structural dimensions of the device can be minimized. The particulars with reference to radial and axial arrangement are then referenced to the rotary axis of the device.

According to the type of embodiment of Claim 10, not only is an electric insulation of the connection distributors from one another guaranteed by the receiving means but also, by the provision of positioning means, for example cams on the receiving means and notches on the associated connection distributor, an exact peripheral positioning of the connection distributor in relation to the receiving means and correspondingly in relation to the device can be guaranteed. Thus, minimal connection paths between the connection distributer and the coil winding are guaranteed simultaneously with simple assembly. Of course the connection distributors could also be fastened securely directly to the rotor and/or the stator without use of any receiving means.

With the method of the invention as in Claim 11, first of all the electrically conducting connection distributors are inserted into receiving means of the connection device, then the connection device fastened securely to the rotor or stator for example by bolting or pinning on, and then the winding ends electrically connected with the associated connection distributors. The connection distributors are guided in one integral piece along the exterior of the device and there form one connection device in turn for each connection group. These steps of the method could advantageously be made automatic and for example could be carried out by industrial

robots.

According to the type of embodiment disclosed in Claim 12, the winding ends can be connected with the associated connection distributors by means of a cutting/clamping device or by gluing, soldering or welding. Preferably high temperature-resistant electrically conductive adhesive substances are used for glue. Preferably the hard-soldering process is used for soldering. When using welding, spot-welding is preferred.

In the type of embodiment of Claim 13, the receiving means are sealed shut with the embedded connection distributors, if necessary with use of a clamp collar. This preferably occurs by dipping in an electrically insulating synthetic resin. Then contact points for the electric connection with the ends of the windings remain accessible on the connection distributors. Alternatively to that, the contact points of the connection distributor provided with a cutting/clamping device could also be cast or filled in, since during the pressing in of the winding ends the insulating layer is penetrated. This use of the procedure has the advantage that the connection device can be set up as a complete structural assembly in and of itself on the rotor or stator and can be completely assembled in one step.

According to the embodiment of Claim 14 the completely assembled and wired rotor or stator is cast in insulating material.

Other advantages, features and individual disclosures of the invention are disclosed by the dependent claims as well as the following description, in which a number of exemplary embodiments are described in some detail with reference to the attached drawings. Therefore the features mentioned in the claims and in the description could in turn be essential to the invention

in and of themselves or in any desired combination.

Fig. 1 shows a cross section through a device according to the invention,

Fig. 2 shows a plan view of the stator of Fig. 1,

Fig. 3 shows the electric wiring of the coil windings,

Fig. 4 shows a section corresponding to the line IV-IV of Fig. 2,

Fig. 5 shows a section along the line V-V of Fig. 2,

Fig. 6 shows a cross section along the line VI-VI of Fig. 2,

Fig. 7 shows an alternative embodiment of the device,

Fig. 8 shows an enlarged section of Fig. 7 in the area of the connection distributors, and

Fig. 9 shows the view IX of the connection mechanical sleeve or bearing of Fig. 7. .

Fig. 1 shows a cross section through a device according to the invention. In this case it has to do with a combined motor/generator device 1 with an interior stator 2 and a rotor 4 running on the exterior around the axis 3. The traditional associated housing is not shown. On the tin-plated core 5 of stator 2 are wound in sequence coil windings 6 in circumferential alignment. The winding ends of the various coil windings are connected electrically with one another with formation of groups of connections, whereby a connection device 7, 8, 9, 10 includes connection distributors 8, 9, 10 running in circumferential alignment, which are inserted in receiving means which can be fastened and sealed onto rotor 2. Connection distributors 8, 9, 10 of each group of connections are formed in the present embodiment by two copper bands bent in approximately semi-circular shape, which are arranged one behind the other in radial direction 20 and are electrically insulated from one another. The copper bands are dimensioned to correspond to the electric currents to be supported, for example they are of a width x thickness of 15 X 1 mm^2. Rotor 4 running on the exterior engages peripherally around the stator and supports permanent

magnets 12 on the surface 11 facing stator 2 in a number corresponding to the number of poles or the number of coil windings 6. Coil windings 6 if necessary can also have one or more symmetrically or unsymmetrically distributed partial taps.

Fig. 2 shows a plan view of the stator 2 of Fig. 1. Of the coil windings 6 arranged over the entire circumference in circumferential direction 13 there are represented for clarity only six coil windings 6a, 6b, 6c. The stator 2 which is represented is wired for a three-phase alternating current connection in a triangular circuit.

Coil windings 6a, 6b, 6c are thus wired each by means of approximately semi-circular connection distributors 8a, 8b; 9a, 9b; 10a, 10b to three connection groups and can be electrically connected from outside the stator by means of a first, second and third mechanical sleeve or bearing 14, 15, 16. The first winding end 17a of coil winding 6a of the first group of connections is connected with connection distributor 8b, whereas the second winding end 17b is connected with connection distributor 9b. The first winding end 18a of coil winding 6b of the second group of connections is connected with connection distributor 9b, whereas the second winding end 18b is connected with connection distributor 10b. The first winding end 19a of coil winding 6c of the third group of connections is connected with connection distributor 10b, and the second winding end 19b is connected with connection distributor 8b. And so forth, for the connection of the corresponding winding ends to connection distributors 8a, 8b, 8c. Both of the connection distributors 8a, 8b are formed in turn by copper strips which are bent approximately in semi-circles made up of one piece at one point of the circumference upward and/or outward and the corresponding ends are bent into formation of a mechanical sleeve or bearing area for an electric connection 14 of this connection group. Correspondingly the same is the case for the two connection distributors 9a, 9b, which in one piece form the connection 15 of the second

connection group, and for connection distributors 10a, 10b, which in one piece form the electric connection 16 of the third connection group.

Fig. 3 shows the electric wiring of the coil windings 6a., 6b, 6c of Fig. 2, arranged alternating in circumferential direction, which are connected parallel within the groups of connections which are formed and as a whole are wired to a three-phase, delta-wound circuit with the three electric connections 14, 15, 16. Insofar as a three-phase-star circuit is required, four connection groups altogether are provided, whereby the star point as needed can be guided over a fourth connection toward the outside of the stator or not. If the possibility of reversal from star- to delta-wound circuit and vice versa is to be present, the two winding ends of the parallel-connected coil windings in turn are to form contacts by connection distributors insulated from one another and are to lead to six electric connections in all.

Fig. 4 shows a section corresponding to line IV-IV of Fig.. 2. The first end 18a of coil winding 6b wound on laminated core 5 is connected electrically with the middle of connection distributor 9a in radial direction 20 by means of a cutting/clamping device 21 configured in one piece therewith. With the pressing in of the insulated winding end 18a the insulation is penetrated by the cutting flank 21a and the electric contact between connection distributor 9a and winding end 18a is produced. With further pressing in of winding end 18a, the cutting off of the nearly flush winding wire occurs. In the area of the connection of winding end 18a to connection distributor 9a the connection distributor 8a on the exterior in radial direction 20 preferably has a notch, in order to guarantee an electrically insulated passage of winding end 18a to the middle of connection distributor 9a in radial direction 20. Alternatively or in supplement hereto, the exterior connection distributor 18a can also have a narrower strip width over its entire length and/or can be inserted more deeply into the receiving means 7, which for example is formed by a

plastic ring provided with grooves to receive said connection distributors 8a, 8b, 9a, 9b, 10a, 10b. Fig. 5 shows a section along line V-V of Fig. 2. Both of the approximately semi-circular connection distributors 9a, 9b according to Fig. 2 are bent radially outward in the area of section V-V in electric contact with one another. In the area of bringing together of the two connection distributors 9a, 9b, the exterior connection distributor 8a aligned in radial direction has a notch, so that connection distributor 9b can be guided past electrically insulated therefrom.

Fig. 6 shows a cross section along line VI-VI of Fig. 2. The two connection distributors 8a, 8b bent semi-circular at this point come in contact with one another on the circumference and are guided together toward the exterior of stator 2. By means for example of a not shown projection provided in the overlapping area, the projection on connection distributor 8a and a convexity provided at the corresponding point of connection distributor 8b, during the insertion and guiding together of the connection distributors 8a, 8b, a simple and precise positioning of connection distributors 8a, 8b in relation to receiving means 7 and in relation to one another is guaranteed. Instead of projection and convexity for example also a sort of groove/spring combination in the associated connection distributors 8a, 8b; 9a, 9b; 10a, 10b could be provided.

Fig. 7 shows an alternative embodiment of the device of the invention, whereby an interior stator 102 is again provided, this time with coil windings 106 -here shown only diagrammatically. The connection distributors 108, 109, 110 connected electrically with one another in this embodiment are arranged one behind the other in axial direction 122 parallel to the rotation axis 103 of the associated and not shown rotor and are electrically insulated from one another by receiving means 107. Fig. 8 shows a cutout enlargement of Fig. 7 in the area of connection distributors 108, 109, 110. Winding end 118a of coil winding 106b is electrically connected by means of the cutting/clamping device 121 with the center of connection distributor 109 in axial direction 122.